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MONTANA'S THIRTY-YEAR MOUNTAIN PINE BEETLE INFESTATION

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From 1911 until 1942 an epidemic infestation of the mountain pine beetle (Dendroctonus monticolae Hopk.) swept through the lodgepole pine forests of Idaho and Montana leaving a waste of dead trees. Little fanfare accompanied this devastation of natural resources, yet it was as thorough as though the area had been covered by fire. It was a condition known for the most part to foresters and lumbermen who were familiar with these forest areas. From time to time as the infestation spread into areas of, shall we say "high visitability," the situation became of some public concern, but in a few years as it passed to the less accessible timber stands it was again forgotten. There are so little data available as to the total loss of pine that the best estimate that can be made is to say that millions of trees were killed.

As this destructive outbreak has now run its course it is the purpose of this paper to bring the available information concerning it, and which is scattered through unpublished reports and correspondence, into a more accessible story. One cannot vouch for the accuracy of all information used, in fact as we now understand infestations of the mountain pine beetle in lodgepole pine, some of the records and deductions made during the early years of this outbreak are subject to real question. It is also possible that some of the areas have been improperly named and described. However the data are the best available, and it is not expected such errors will detract seriously from the value of this narrative.

Early Records of Forest Insect Conditions Within Area Where Infestation Originated

The infestation with which this story is concerned was reported first from Flathead County, Montana, in 1910. Although there is no connection that can be shown between this infestation and the earlier mountain pine beetle outbreaks as shown in the following records, they do provide an interesting background of forest insect conditions within the area.

In 1898 Mr. H. B. Ayres* wrote as follows concerning the destruction of white pine insects:

"White pine (Pinus monticola) occurs in the mountain valleys, sometimes reaching a height of 150 feet and a diameter of 24 and even 30 inches on the stump. Along the trail from Columbia Falls to the Coal Banks in the valley of the North Fork of the Flathead River most of the white pine was found. Here the trees were tall and crowded. Several of the heaviest acres were selected and carefully estimated and found to contain from 25,000 to 30,000 feet per acre. It is to be regretted that much of this white pine is dying. The dying trees were found infested with bark borers. Part of the affected area had been slightly injured by fires escaping from hunting camps, but the trees were dying also beyond the area burned. But few trees were dying this year and on these the leaves were turning yellow. On November 3rd about one-third of the leaves on the dying trees were yellow. The bark of these

*Ayres, H.B. 1898. 19th Annual Report, United States Geological Survey.

trees was found studded with reddish-brown borings of the larvae of the beetle which Mr. L. O. Howard has identified as Dendroctonus terebrans*. On cutting into the bark and wood the larvae and beetles were found in great numbers in and under the bark only. The wood had not been penetrated. The sapwood was found to be thoroughly blued, indicating that this portion of the tree had been inactive or practically dead during the warm season. Mr. Howard states that this and allied species of beetles have been noted in the northern states from New England to Oregon. It is doubtful whether these insects attack vigorous trees, but it seems probable that they attack and kill trees that are weakened from any cause, and that possibly where these beetles have bred in great numbers in trees injured by fire, they may attack and kill trees otherwise."

No further records of forest insect infestations are available for the period following Mr. Ayre's report until in 1909 Mr. Josef Brunner** reported that not less than five hundred million board feet of timber has been destroyed in Flathead County, Montana, during the past 10 years. Very little information as to the location of these infested areas was given in Mr. Brunner's report, however it can be assumed that a number of different localities and tree species were involved. In this report the situation of the North Fork of the Flathead River, previously reported by Mr. Ayres, was discussed in considerable detail, and a similar condition on the South Fork of the Flathead River was mentioned. This report also contained mention of severe Douglas-fir losses which were considered as being greater than in any other tree species.

These early records dispel the often advanced thought that barkbeetle epidemics are innovations associated with an intense commercial use of a forest area. They indicate that such situations have always occurred in overmature or decadent timber stands, and in this instance show that the forests of this general area were in a condition susceptible to barkbeetle attack. Unfortunately our story starts with the existence of an epidemic. Although other infestations may have contributed to the build-up of this condition, data of such an occurrence are not available, nor can such relationships be correctly assumed.

The Story of the Mountain Pine Beetle Infestation Which Ravaged the Lodgepole Pine and Whitebark Pine Stands of Idaho and Montana

This story starts in 1909 and 1910 with reports of severe timber losses by forest rangers of the Flathead National Forest. Although these reports omitted mention of timber species and exact locations, it is assumed that they referred to the severe lodgepole pine infestation which was subsequently known to have existed at that time. However, it was not until the following season that the magnitude of the situation was fully appreciated and its location known.

1911

In August 1911, Lieberg and Wagner*** reported that there were some 10,000 infested lodgepole pine trees on the south shore of Swan Lake, in sections 30, 31, T. 26 N., R. 18 W., and in sections 25, 26, 35, and 36, T. 26 N., R. 19 W. Later in the season the estimate as to the number of infested trees was raised to 30,000 and considered as an increase of 100 percent over the loss of the previous season. This situation was described by Brunner as follows:

"If the depredations are not checked this season, there can be but little doubt that within a few years almost all the pine in the vicinity of Swan Lake will have fallen

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* Later identified as Dendroctonus monticolae Hopk.

** Brunner, Josef, Agent, Bureau of Entomology, U.S.D.A.

***Frank Lieberg, Albert Wagner, Agents, Bureau of Entomology, U.S.D.A.

victim to Dendroctonus monticolae, the most destructive beetle in the Rocky Mountain Region."

Mr. Brunner little realized the full significance of his prophecy at the time it was made, for in reality the ultimate timber loss was far more serious than anyone could have imagined or anticipated at that time.

This alarming forest condition was given some publicity and considerable interest was aroused. Attempts to bring the public and private timber owners of the forest lands in question to some agreement as to the institution of artificial control met with considerable difficulty. However these problems were eventually cleared and cooperative working agreements established between the United States Forest Service and the Bureau of Entomology; the Forest Service and the Anaconda Copper Mining Company, and a formal agreement between the United States Department of Agriculture and the State of Montana.

Before proceeding further with this story some mention should be made of another mountain pine beetle infestation which had been reported from an area some 120 miles to the south of Swan Lake. This infestation was within the lodgepole pine stands of the Big Hole Basin, Beaverhead National Forest, and although reported in 1911, its seriousness was not determined until the following season. In May 1912, Mason and Clark* placed the number of infested trees at between 34,000 and 43,000. Later in the season control measures were instituted and some 2,326 trees treated at a cost of $1,734. Additional control work was conducted in 1913 and $7,800 spent in treating 23,393 trees. At the institution of this project the infested trees were felled and peeled. Later in the project this procedure was abandoned in favor of peeling the standing infested trees with long handled spuds. The average height peeled was about 12 feet.

In June 1912, Brunner reported a condition which he had encountered in connection with his examination of the Big Hole Basin infestation which should be mentioned at this time as it will be referred to later in this story. Mr. Brunner wrote of this condition as follows:

". . . The larvae in the killed trees (1911 attacks) were practically all dead, and I discovered but one tree of the normal infestation which contained living larvae at breast high. This was one of the biggest trees killed. Higher up towards the top of this tree the bark had been stripped off by wood-peckers, which is true of all the large trees which probably harbored living larvae at the end of the winter. The bark of the trees in that region is extremely thin and I have a strong suspicion that the larvae died on account of the drying up of the cambium. There are over the entire area of infestation about 300 or 400 lodgepole trees which were infested very late during autumn. The parent beetles are still living and the larvae are so small that they look like they may have developed from eggs this spring. . . . it seems desirable that these trees should be cut and barked . . . Four laborers under two forest officers could readily do this work."

From the number of trees which were treated in 1912 and 1913 it would seem that the seriousness of this infestation had been under estimated in this report.

Late in 1913 Brunner considered the Big Hole Basin control project a success, although it is quite evident that only a relatively small portion of the infested trees was treated. However no further damage was reported, and it was quite evident that when this area again came into public prominence in 1924, that there had been but little if any loss subsequent to 1913. Although at that time no one could assume that there could be any relationship between the Big Hole Basin and the Swan Lake infestations, as the story of the later situation continues the reason for including this incident will be evident.

*D. T. Mason, ____ Clark, Officers, United States Forest Service.

1912

In returning to the story of the Swan Lake infestation we find that in accordance with cooperative plans previously made, that control measures were instituted in January 1912, with the Forest Service in charge of the operation. Funds for this project were contributed by the Forest Service, $5,000; Anaconda Copper Mining Company, $800; and the State of Montana, $550. Of an estimated 30,000 infested lodgepole pine trees on this area, 28,000 were cut in accordance with the recommendations of the Bureau of Entomology. The method of treatment is not shown in any available record, however it is believed that the trees were cut, skidded into decks and burned. Some logs may have been removed for commercial use. On March 20, 1912, Brunner wrote:

"On Swan Lake the infested trees are going down at a rapid rate; the work is restricted to the cutting of the trees and making them ready for dragging them together as soon as the crust of the snow softens."

Our present knowledge of mountain pine beetle infestations in lodgepole pine indicates that the strategy of this project was not well founded. Past experiences have shown that such blocks of heavy infestation are but the centers of far more widespread infestations. The institution of control within such areas or centers of infestation may show satisfactory results for the immediate area, but it will have no effect upon the advance infestation which has already become established in adjacent timber stands.

1913

In his annual report of June 1913, Brunner commented on the Swan Lake project as follows:

"At this date the result is not known, but the work was not done as thoroughly . . . as it could have been done with the funds used, and there is a likelihood that the invasion there is not definitely closed."

Regardless of the anticipated failure of this project, later in the same month he wired the Washington office of the Bureau of Entomology:

"Result Swan Lake beneficial. Five thousand trees infested. Forest Service spending their five hundred dollars uselessly now."

No further data are available as to the status of this infestation, nor was any explanation given as to why the 5,000 trees reported as infested should not be treated. From these reports one concludes that an accurate record of this situation was not available.

At the time the Swan Lake project was reported as being successful, Kneiff* reported a marked increase in the severity of the insect situation along the South Fork of the Flathead River. His report stated:

"I found more bugs on the South Fork than I have seen anywhere else. From Hungry Horse up to Dead Horse Creek I could count from 4 to 5 to 15 and 20 infested trees in a place right along the trail. From all appearances the beetles are increasing very fast through that whole country and are doing extensive damage, mostly in white pine, some lodgepole pine and spruce . . ."

Kneiff later estimated that there were not less than 20,000 infested trees in that general area, the upper portion of which was but 12 miles to the east of the Swan Lake project.

Kneiff, _____, Agent, Bureau of Entomology, U.S.D.A.

During this same season a report was made by forest officers as to an infestation of the mountain pine beetle in the Clearwater drainage of the Big Blackfoot River some 40 miles to the south of Swan Lake. In October 1913 Brunner wrote of this situation as follows:

". . . there is an immense amount of lodgepole pine killed in the hills west of Clearwater town. Further up Clearwater River from Seeley Lake up and beginning near the forest ranger station, clusters of D. monticolae infested lodgepole pine from twenty to over a hundred are numerous along the road and in the hills. This condition continues to near the vicinity of Rainy Lake."

It is apparent that at that time no relationship was assumed between the infestations on the South Fork of the Flathead River, the Clearwater River, and Swan Lake. In June of 1914, Chief Forester Graves wrote of the Swan Lake project as follows:

"Recent reports received from District 1 indicate that the control operation conducted at Swan Lake on the Flathead National Forest during the seasons of 1912 and 1913 were successful in every respect and that the infestation on that area has been stamped out completely."

Brunner, in his annual report for 1915 considered the damage at Swan Lake as absolutely ended according to forest rangers and people who live in the area. Present type maps indicate that the Swan Lake infestation was in a somewhat isolated and relatively small body of lodgepole pine. The area where control was reported as having been conducted is now shown on forest type maps as a spruce stand, with a spot of some 1,000 acres or more of lodgepole pine type immediately adjacent to the west. So although the infestation in this area may have been checked by control, it is more than probable that at the time control was instituted a large percent (Brunner estimated 80%) of the mature lodgepole pine had already been killed. Furthermore, regardless of what success was attained in this small area, it had little effect upon the general infestation which was subsequently found to exist on all sides.

1914 - 1917

In 1914 the writer recorded large blocks of red-topped pine trees in the lower Clearwater River area and in the head of the Elk Creek drainage of the Blackfoot River. Some of these blocks of infested trees comprised thousands of acres on which most of the larger trees had been killed. However it was not until 1917 that information was obtained from the upper Swan River drainage, between the Swan Lake and the severe Clearwater River infestations. In May 1917, Forest Officers Jaenicke and Wyman made a general inspection of the infested area, which was followed by a more thorough examination by Wyman in July and August of the same season.

In their reports of these examinations Jaenicke and Wyman divided the infested area into two so-called infestation units which were known as the Upper Swan River Area and the Clearwater or Seeley Lake Unit. The Upper Swan River Area was described as being bounded by the Mission Range on the west, the Swan-Flathead Range on the east, Lion Creek and Cedar Creek on the north, and to the south it merged with the Seeley Lake Area. The Seeley Lake Area comprised the Clearwater drainage and adjacent territories of the Blackfoot River drainage.

In the Upper Swan River Area the infestation was concentrated in a strip of timber along Swan River between the Gordon Ranch and Lion Creek. This area was described as being about 6 miles in width and some 20 miles in length. Severe centers of infestation existed around the Gordon Ranch and the Anderson and Halpen homesteads, with lighter losses on the higher elevations along the sides of the valley. An estimate of the 1917 loss of timber in the Swan River area was set at 12 percent of

the total stand of lodgepole with the prior loss being placed at 10 percent. In addition to the loss of lodgepole pine the damage to the ponderosa pine stands for the year 1917 was set at 5 percent of the total volume.

In discussing the Seeley Lake or Clearwater infestation, Wyman stated that prior to 1913 there were light losses scattered over the entire area. This conforms fairly well with previous information, however in 1912 it was reported that there was a noticeable increase in beetle work west of Rainy Lake, with an infestation of 1,000 lodgepole pine trees. Although at that time the situation was not considered as serious, the following year (1913) there were some 15,000 acres of heavy lodgepole infestation to the west of Rainy, Inez, and Seeley Lakes, with an estimate of 100,000 trees. By 1914 this heavy infestation had increased to 1,000,000 lodgepole pine trees, with a general extension and build-up of the situation throughout the entire area. By 1916 there were an estimated 3,500,000 infested lodgepole pine trees within the original area with epidemic conditions existing throughout.

It is regretted that even some of the questions that occur at this time relative to the spread, sources of infestation, etc., cannot be answered. By 1917 this general situation was considered in all reports and correspondence as being composed of three separate areas of lodgepole pine infestation, namely, Swan Lake, Upper Swan River drainage, and the Clearwater or Seeley Lake area. This division had little justification aside from geographic descriptions, as there were no breaks in the terrain which could be considered as entomological boundaries. Unfortunately there are no data which will permit deductions as to which area contributed to the build-up of the infestation within the others, or if they were all independent situations. It is known that the Swan Lake infestation reached epidemic proportions in 1911, while in the other two areas the losses were reported as negligible prior to 1913. It is also obvious that by 1917 a severe infestation extended southward from Swan Lake to the mouth of the Clearwater drainage of the Blackfoot River. Again it is unfortunate that no data are available as to the development of the infestation in the Upper Swan River area, as such information would have contributed to an answer as to the spread of this epidemic.

1918 - 1920

During this period of years this insect situation was apparently relegated to a position of secondary forestry importance as there is but little information available concerning it. On June 8, 1918, Wyman considered the prospects for a cessation of insect damage on the Swan River and Seeley Lake units as being much brighter than during the previous year. This statement was limited to these areas only. In his report of this situation Mr. Wyman wrote as follows:

"Around sections . . . (Swan River area) . . . the heaviest emergence will take place but even here only 35% of the trees attacked last fall will produce an average brood. Woodpeckers and parasitic diptera have made large inroads among the bark-beetles but no predacious beetles were seen. These predacious beetles were common in infested yellow pine on the Missoula Forest.

"Some 65 trees were tallied at random throughout the locality of heaviest infestation, 34% had no live beetles or larvae in them, 28% had a very small brood, 18% had a moderately large brood, and 20% had 30 or more larvae to the square foot of bark surface. In the northern part of the area the percentage of trees containing large broods is less.

"It is felt that the climax of the infestation has been reached in this vicinity. Here as well as on the Missoula Forest, the beetles were largely in small open-grown lodgepole where they were unable to complete their life cycle."

Mr. Wyman's comments on the Seeley Lake infestation follow:

"The insect situation around Clearwater, Ovando and in the Clearwater drainage area on the Missoula Forest showed a marked improvement in April and May 1918. The Seeley Lake, Marshall Creek and Salmon Lake fires cleaned up large areas of timber which were heavily infested with the mountain pine beetle. Fortunately these fires occurred after the main emergence and flight of beetles had taken place and of course all insects in the trees at the time the fire swept through were killed.

"A few hundred trees were subsequently attacked by insects, but the drying out of the bark was effected quickly enough to prevent any of the brood from maturing.

"In the areas not reached by the fire predacious beetles, Rhizophagus scalpturatus belonging to the Nitidulidae, predacious larvae of some dipterous insect not yet identified, and woodpeckers have done yeoman work so that the emergence will be much smaller than it has been for several years.

"The heaviest emergence will occur at Monture Creek just outside the forest boundary and northeast of Corlett where some damage may be expected this fall. Throughout the district the insects seem to have gone into small lodgepoles to a greater extent than ever before and these trees dry out so rapidly that the beetle larvae are unable to mature. The trees thus act as traps."

From Wyman's reports it can be assumed that these infestations were considered as having run their normal course and that the damage in these areas was practically at an end. Apparently the seriousness of these situations was not fully appreciated at that time, for in December 1920 Supervisor White of the Missoula Forest wrote as follows to the Regional Forester:

"There is an alarming amount of bug killed timber in the Blackfoot River watershed. Forest officers have observed evidences of this infestation all the way from Gold Creek to Monture Creek and beyond. Something like twenty townships are involved. Not all the timber in this area is dead by any means, but patches of insect killed trees are all too common.

"Today a Mr. Fisk was in the office describing a bad insect infestation around Lincoln. Fully two townships are involved there. . . . Along about 1916 the insects appear to have done the most damage. Probably the worst is over with, we don't know. . . . It is also probable that the damage is still spreading, we don't know. We believe it is safe to say that insects are responsible for greater losses of timber during the last eleven years in the Blackfoot River watershed than fire."

1921 - 1923

At the request of the Regional Forester an examination of the Missoula National Forest area was made by the writer in May 1921. This examination showed that in the Clearwater drainage of the Blackfoot River where the severe infestation existed in 1917, most of the larger trees had been killed with but little active infestation remaining in the area. However in the Monture Creek drainage a few miles to the east, where the same destruction of large trees had occurred, the infestation was still active on many of the smaller tributary streams and on the higher ridges and divides. In these areas there were patches of red tops (1920 attacks) which varied from 10 to 200 acres or more in size.

Furthermore, in the Lincoln Basin some 25 miles to the southeast of the Monture Creek area the situation was far more serious. On the southwest, west, and northwest sides of this basin, which lies at the head of the Big Blackfoot River, the mountain sides appeared to be of a solid red color from the faded foliage of the

insect killed lodgepole pine. Severe infestations of this insect were recorded also near Helmsville, Montana, where large areas of red-topped trees could be seen. So again it seemed that although the Seeley Lake infestation had died down, presumably from a want of suitable host material, the infestation had continued southward and in 1919 had attacked and killed millions of trees around Lincoln, Montana. This examination did not, nor could it hope to, reveal the detailed progress of this southern spread, but it did show that in 1921 a so-called center of infestation was then present some 60 miles or more to the southeast of Seeley Lake where a comparable condition had existed in 1917.

In 1922 an extensive examination of the Helena and Deerlodge National Forests revealed the existence of a severe lodgepole infestation extending south from the village of Lincoln along both sides of the Continental Divide to the south side of the Clarks Fork River. In July 1923, Elers Koch, Assistant District Forester of Region 1, wrote of this infestation as follows:

"The infestation has extended south as far as the head of Harvey Creek and the head of Lower Willow Creek. Many groups of yellow pine were attacked over the same area. In the main body of lodgepole pine in the Rock Creek Basin no infestation was noted except the occasional normal amount. It will be nothing less than a calamity if the attacks spread through upper Rock Creek into the Bitterroot and Big Hole, and it appears that there is nothing in the way of such spread unless the attack is checked from natural causes."

It will be seen that Mr. Koch's fears were well founded.

In addition to the southern extension of the infestation from Lincoln, Montana, a few spots of light infestation were reported from the Big Belt Mountains in 1922, in areas which were some 65 miles east of the Lincoln situation. One cannot say that these small areas of infestation were connected with the more severe situations to the west; however their occurrence at this time and the fact that such flights of beetles do not seem to be an impossibility, permits such an assumption if one cares to make it. Control measures were instituted in the most heavily infested of these small areas in 1923, which with the aid of natural control agents successfully reduced the threat of this situation.

To make this story as complete as possible it is necessary to turn back to the Blackfeet (now known as the Flathead) National Forest, to record the occurrence of an infestation to the north of Swan Lake. In December 1921, Forest Officer Ellis reported that an infestation which had started in 1918, had during subsequent years destroyed some 90 percent of the lodgepole pine in the Swamp Creek drainage and 75 percent in the Fortine Creek area. In 1922 it was found that serious insect situations existed in all mature lodgepole pine stands of that general forest area. These situations were not confined to the Blackfeet National Forest, but extended to the northwest across Pinkham Ridge into the Kootenai National Forest. A few years later (1925) a severe lodgepole infestation was recorded on the west fork of the Yaak River just south of the Canadian Border. These outbreaks continued until nearly all trees above 8 inches in diameter were killed.

And so to the north as well as to the south of Swan Lake, where in 1911 epidemic conditions existed, a series of subsequent progressive infestations occurred which eventually spread through nearly all lodgepole stands of the region. This destruction of timber was not confined to the United States as severe damage was reported from areas north of the Canadian Border.

1924

The story now returns to the southern limits of this infestation where various control operations were made in what proved to be futile efforts to check this invasion. The first of these was made in the spring of 1924 when a few hundred dollars were made available, and with little preparation, the first attempt at a Barrier Plan of Control was instituted in the Philipsburg Basin of the Missoula (now Deerlodge) National Forest. A line was extended westward from Silver Lake along the Philipsburg-Wilma road which crossed the Continental Divide to the Bitterroot River on the ridge between Stony Creek and the West Fork of Rock Creek. This imaginary line established the northern boundary of what was known as "No Bugs Land," in which all infested trees were to be treated as long as beetles continued to move southward across the defense line. Although this project might have been sound in theory, its practical application was properly questioned. Furthermore, as this operation was instituted without the privilege of a thorough examination of the "No Bugs Land," it was feared that the defense line might not have been located so as to exclude all of the advance spots of heavy infestation from the zone of control. To safeguard against this possibility, plans were made for a thorough examination of the entire area later in the season.

Regardless of these doubts and fears the project was instituted in May 1924, and a total of 1,010 trees treated at a cost of $826.00. As no systematic spotting survey was possible, red-topped trees (1922 attacks) were used to indicate the location of infested (1923 attacks) trees. This was not an effective procedure, but the best that could be done with the funds available. As the territory covered by this operation included some 22 sections, it is too much to expect that all infested trees were located and treated.

It was just as well that a larger sum of money was not spent on this project, as the survey conducted later in the season confirmed previously held fears that the beetles had crossed the "No Bugs Land" of the Philipsburg Basin even before it was established. Not only was the situation in the "No Bugs Land" far more severe than had been anticipated, but a severe epidemic infestation was recorded in the lodgepole pine stands on the head of the East Fork of the Bitterroot River, which was south of the defense area. In this area entire mountain sides were red with the discolored foliage of trees attacked in 1923. Although an extensive examination had been made of the East Fork of the Bitterroot River in 1921, the few scattered red tops (1919 attacks) and some old losses did not indicate such a potentially serious infestation as was recorded three years later. In the Big Hole Basin of the Beaverhead National Forest to the south of the Bitterroot infestation and where artificial control operations had been reported as successful in 1913, there was a light infestation of small groups of 1924 attacked lodgepole pine with a light loss during the two previous seasons. It was obvious that in view of the condition revealed by the 1924 survey, that the continuation of the control project as adopted on the Missoula Forest the previous season would be of no avail and it was discontinued.

1925

The seriousness of this infestation which was already destroying the lodgepole forests of the Bitterroot was now fully appreciated. Again during the winter of 1924-1925 an allotment of $8,000 was made available for the control of the Bitterroot infestation. It was obvious that this sum of money was totally inadequate and the only benefits that could be anticipated, and these were remote, were through the treatment of the outlying or advance groups of infested trees. In putting this plan into operation another imaginary line was established across the East Fork of the Bitterroot River in front of the area of severe infestation. The plan of attack called for the treatment of all infested trees to the west of this line, with

vaporous hopes that something would happen to the beetles on the east side of the dead line. Something did happen, but it was not what had been hoped for, as upon emergence tremendous numbers of beetles moved across the line into the treated area beyond.

In addition to the Bitterroot project a small mobile crew was placed in the Big Hole Basin to treat the scattered groups of infested trees that had been reported the previous season. This action was considered essential to prevent the existing light infestation from developing to more serious proportions. It is now quite obvious that in taking such action, that the spread potentials of mountain pine beetle infestations such as existed on the East Fork of the Bitterroot were not fully appreciated at that time.

Surveys conducted late in the summer of 1925 showed that the heavy infestation on the Bitterroot had moved several miles down the river, and that there was a marked increase in the severity of the Big Hole Basin situation. It was subsequently shown that in the Big Hole Basin the infestation was far more severe than indicated by the survey, which as we now understand the need for surveys was far from adequate. These established facts demonstrated quite conclusively that the wings of the mountain pine beetle were decidedly functional and that flights of unknown distances were possible. Although this realization seemed to eliminate all hopes of success in connection with the so-called "defense-line" or "advance-spot" theory of control, the Bitterroot project was not then abandoned.

1926

In the spring of 1926 the sum of $17,000 was spent in making a further effort to check the continued spread of this outbreak. Of this sum $5,000 were spent in treating the advance groups of infested trees in the heads of the Tolan, Meadow, Mink, and Springer Creek drainages, and along the Tolan-Meadow Creek divide of the Bitterroot River. The remaining $12,000 were spent in an attempted clean-up of the infestation on the west side of the Big Hole Basin, in an area across the Continental Divide and adjacent to the heavy Bitterroot epidemic. It is evident that again this operation was based upon wishful thinking, with the same assumption that something would happen to the hordes of barkbeetles which were still in the thousands upon thousands of untreated trees. Again this something did happen for upon emergence the beetles moved across the control lines to areas of living trees.

A total of 1,244 trees was treated on the Bitterroot project, which had no recordable effect in checking the continued spread of the beetles. The results obtained demonstrated the futility of continuing this strategy of control and the Bitterroot project was discontinued. The subsequent destruction of timber throughout the lodgepole pine stands of the Bitterroot is now a matter of history.

In the Big Hole Basin a total of 5,271 trees was treated which resulted in a thorough clean-up of the infestation on all the control areas. Surveys conducted later in the season showed that not only had these thoroughly treated areas been reinfested to a degree equally as severe as the previous year, but it was also found that the infestation now covered a much larger area. The presence of a heavy concentration of infested trees in the Mussigbrod Pass on top of the Continental Divide left little doubt as to the source of the Big Hole Basin infestation.

The timber stands on the east and west sides of the Big Hole Basin are separated by an open timberless area which varies in width from 12 to 20 miles. At the time of the 1926 survey the east side areas were examined for the presence of red-topped (1925 attacks) trees. As none were recorded it was assumed that the timberless area had acted as an effective barrier to the spread of the beetles. It was subsequently found that this assumption was in error. However the existing status of the

situation, which became known as the Big Hole Basin infestation, demonstrated the spread potentials of such epidemics.

1927

Although the situation which existed at that time was far from encouraging, the value of the timber stands of the Beaverhead and adjacent national forests to the south was considered as being more than sufficient to justify further efforts to stop the spread of this outbreak. In the spring of 1927 the sum of $35,000 was spent in treating some 17,546 infested lodgepole pine trees on approximately 18,000 acres, along the west side of the basin. Although there was no longer any question as to the Bitterroot infestation spreading into the Big Hole Basin, it was hoped that what insects did cross the Continental Divide would be in the nature of a side-wash from the main flight of beetles down the Bitterroot Valley. Obviously the success of this plan, which is now realized as being one of wishful thinking only, depended upon the treatment of all infestation which might cross the Continental Divide, until such time as the source of beetle supply was exhausted. Furthermore, it was realized that to obtain success it would be necessary to spend large sums of money over a period of years.

During the 1927 project a thorough clean-up was made of the infestation on all portions of the treated areas. Surveys conducted later in the season showed that the anticipated danger of the Bitterroot infestation had not been underestimated. Not only were the treated areas heavily reinfested, but it was found that the timber stands on the east side of the basin were infested to a degree which could not be ignored. At the time the 1927 survey was conducted the trees which had been attacked in 1926 appeared as "red tops," which was the first visual evidence of damage in this area. It will be recalled that in 1926 there were no red tops (1925 attacks) to be seen. This discovery resulted in an extension of the survey to all areas of the basin which were found to be infested.

To add to the general feeling of uncertainty concerning the ultimate success of this control project, a severe infestation of the mountain pine beetle was recorded on the Salmon National Forest, Idaho, which although adjacent to the southern portions of the Big Hole Basin, was separated by the Continental Divide. The possibility that this newly discovered infestation had or would become an additional source of reinfestation to the treated areas within the Big Hole Basin was more than just a potential threat.

1928

Regardless of the 68,000 infested trees within the timber stands of the Big Hole Basin as indicated by the 1927 survey, as well as the fact that there were now two sources from which reinfestation could occur, it was decided that the timber values at stake warranted a still further attempt to stop the southern spread of this destructive outbreak. The same strategy of control was employed, and $100,000 were made available for the treatment of infested trees throughout this tremendous acreage. This operation, which at that time was the largest barkbeetle control project ever undertaken, was instituted on the 1st of May and closed the latter part of June 1928. A total of 55,045 trees was treated at a cost of $98,377, but again the funds and time did not permit the treatment of all infested areas.

Surveys conducted in the fall of 1928 showed that within the area where in 1927 some 68,000 infested trees had been recorded, and of which 55,045 had been treated, there were 203,447. Additional infestation in areas to the south of the basin increased this figure to 321,372 infested trees for the Beaverhead National Forest. To add to this situation, which of itself was not pleasant to contemplate, two areas of mountain pine beetle infestation were discovered and treated on the Targhee National

Forest. This forest is on the west side of the Continental Divide and to the immediate south and east of the Beaverhead. One of the Targhee areas of infestation was 80 miles from the nearest severe infestations on the Salmon and Beaverhead, while the other was at least 120 miles distant. A survey of the Targhee Forest later in the season indicated a much larger infested area than had been previously assumed, with at least 30,000 infested trees. The source of the Targhee infestation was and remained a question for which a positive answer could not be given.

The existing sources of beetle supply, the severe infestation already present in the Big Hole Basin, and the fact that there existed an alarming infestation miles to the south of the control area placed the continuation of the Big Hole Basin project in an untenable position. Several counter plans of control were suggested, but as the ultimate results all seemed to be the same, it was recommended that no further control work be conducted on the Beaverhead National Forest.

Before proceeding further with this story it seems advisable to summarize the several threads of the situation as it existed in 1928. From the East Fork of the Bitterroot River the infestation which in 1924 was concentrated on a relatively small area above the East Fork Ranger Station had spread to the west, north, and south. To the west there were severe situations in the Bertie Lord, Moose, and Martin Creek drainages of the Bitterroot Forest, and in the Rock Creek area of the Missoula Forest which in 1923 was considered as insect free. To the south the Mink and Springer Creek drainages and the heads of Tolan and Meadow Creeks of the Bitterroot Forest all appeared as solid blocks of infested trees. Further south the insects had spread along the Continental Divide and to the north along the west side of the Bitterroot valley on the Idaho-Montana divide. Although there were some losses in the lodgepole pine stands along the east side of the Bitterroot Valley they were not overly severe. From the Salmon National Forest the infestation had spread westward and eventually ravaged all lodgepole pine forests of the State of Idaho. On the Beaverhead Forest all lodgepole pine stands were heavily infested with tremendous losses occurring.

1929

In continuing the story of the southern movement of this destructive forest insect outbreak we return to the situation as it existed at the time the Big Hole Basin control project was discontinued in 1928. It will be recalled that following the control work of that season the treated areas had been heavily reinfested, and areas of infested trees had been reported from the Targhee National Forest which is to the south and east of the Beaverhead. This situation resulted in another advance of the control zone and a new strategy of attack. On the west side of the Continental Divide an attempt was to be made to treat all infested trees on the Targhee National Forest until such time as no further reinfestation occurred. On the east side of the divide it was hoped that the timberless areas between the Beaverhead Forest and what was then the Madison National Forest would act as a partial check at least to a continued southern spread of the beetles. The forests to the south of this timberless area were to be kept under annual surveillance and prompt action taken to treat all infestation which appeared. This plan appeared to be the best bit of strategy possible with good promise of success to be obtained; however, the story continues.

In 1928 the infested area on the Targhee National Forest increased from 5,000 to 14,800 acres and a total of 31,205 trees was treated in the spring of 1929 as compared to some 2,700 the previous season. To add to this alarming condition small areas of infested lodgepole pine trees were recorded on the Teton, Wyoming, Caribou, and Cache National Forests, which are to the south and east of the Targhee. Control measures were instituted for the treatment of these scattered areas of infested trees in the spring of 1929. These new areas of bark beetle infestation in forests previously considered as free from insects were located by comprehensive surveys, the importance of which was then fully appreciated as being an essential part of all

control operations. Although the data obtained from these surveys showed that the zone of infestation was again far more wide spread than had been anticipated, however the importance of checking the ravages of this outbreak was considered as justifying further efforts of control.

1930

Surveys conducted in the fall of 1929 showed still further increases in the severity and extension of all previously reported infestations. On the Targhee National Forest the infestation was distributed over an area of 67,900 acres with comparable increases reported from other adjacent forests. Control measures were instituted again in the spring of 1930, and some 73,224 infested trees treated as follows: Targhee 30,064, Teton 4,515, Wyoming 17,160, Caribou 4,327, and 17,158 on the Cache National Forest.

Later in the season an intensive program of forest insect surveys revealed further discouraging information. It was shown that the insects had crossed the timberless area between the Beaverhead and Madison National Forests, with infestations reported from the Sheep Canyon Hills, an area of public domain, and on the head of the Black Tail Creek drainage. The nearest Beaverhead infestation to these new areas was some 25 miles to the west. This discovery showed that the expected advantage to be gained from the timberless area between these two forests was remote and perhaps of little importance. These surveys also showed that regardless of the control work conducted there had been but little change in the severity of the infestation on the Targhee, Teton, Wyoming, and Cache National Forests, with a marked increase on the Caribou. To add further gloom to the picture a light infestation of some 3,000 trees in the southwest corner of the Yellowstone National Park was reported for the first time.

1931

Although each year the ultimate promise of success seemed less hopeful, the commercial and scenic values at stake seemed to justify once more the continued effort to check this destruction of timber. As a result all of the infested areas within the zone of control, which included the Sheep Canyon Hills and the Black Tail drainage of the Madison Forest, were covered by control in the spring of 1931. However, surveys conducted in the fall of that year, and on a more intensive scale than ever before, demonstrated the futility of this so-called all-out effort of control. In the Sheep Canyon Hills and Black Tail Creek areas the infestation had increased several fold. On the Targhee Forest the size of the infested area was shown to be some 480,000 acres, on which there were 119,000 infested trees. With little if any change in the insect situation on the Caribou, the Teton, Wyoming, and Cache National Forests reported decreased infestations within the areas covered by control. A general survey of the Yellowstone National Park showed that practically all white bark pine stands were infested with the mountain pine beetle.

A careful analysis of the situation as it existed in 1931 showed little hope of ever checking the southern advance of this destructive barkbeetle outbreak, if it continued in its existing status of severity. In the event that the severity of the epidemic was checked by some natural cause, then further efforts of control would still be considered as questionable. In view of these quite evident facts it was decided to drop the project and hope for a natural decline in the severity of the infestation. The wisdom of that decision can never be determined, although it would seem at this time that the action was proper. Questions can be raised as to the value of the control work conducted during these years. Although no answer can be given, it would seem that the many thousands of trees treated would have reduced the beetle population to a degree that it must have had some effect upon the subsequent damage.

During the years subsequent to the cessation of control work the severity of the infestation increased, involving larger and new areas. Examples of this increase are the Targhee and Teton National Forests where in 1934 there were 485,800 and 287,000 infested trees respectively. On some of the other forests adjacent to the Targhee there were similar gains, while on others the infestation had decreased in severity.

It can be considered that this infestation reached its maximum destruction in 1934, with a sharp decline in its severity during the next few years. This reduction was confined primarily to lodgepole pine, as severe mountain pine beetle epidemics persisted in white bark pine areas until 1938, with heavy losses occurring in some areas in 1940. All white bark pine stands of the Yellowstone National Park and adjacent national forests were seriously depleted during the duration of this epidemic.

In considering the natural decline of this epidemic in lodgepole it will be recalled that Brunner in his report of the Big Hole Basin infestation in 1912 made the following statement:

"The larvae in the killed trees (1911 attacks) were practically all dead, and I discovered but one tree of the normal infestation which contained living larvae at breast high."

Mr. Brunner offered the following explanation as to the cause of this abnormal mortality:

"The bark of the trees in that region is extremely thin and I have a strong suspicion that the larvae died on account of the drying up of the cambium."

Strangely, there was a recurrence of this abnormal mortality associated with the sudden cessation of the infestation in the Big Hole Basin in 1933. In June of that year it was found that a large percentage of the beetle larvae within the 1932 attacked trees were dead. No positive explanation of this condition could be given at that time, but with our present knowledge the assumption that it was associated with some abnormal weather condition can be confirmed. The occurrence of these two instances of abnormal mortality and their relation to the subsequent status of the infestation is worthy of mention in this story.

1934-

During the summer of 1934, Doctor L. A. Strong, Chief of the Bureau of Entomology and Plant Quarantine, with representatives from the Office of the Secretary of Agriculture, visited the Beaverhead National Forest to obtain first-hand information as to the destruction of timber by the mountain pine beetle. The seriousness of this destruction aroused their interest in fears previously expressed for the future of the scenic lodgepole pine stands of the Yellowstone National Park. This interest resulted in a reconsideration of the possibilities for an all-out effort to prevent future destruction of commercial and scenic forest timber. As the first step in determining the feasibility of this project, surveys were conducted of the Yellowstone National Park and all adjacent national forests to determine the existing status of the mountain pine beetle infestation. Data obtained from these surveys showed that in the area which would need be placed under control, there were some 1,325,000 infested trees distributed over an area of 2,231,000 acres. The cost of treating these trees in the spring of 1935 was placed at $4,500,000 with an assurance that several years of maintenance control would be necessary.

Complete details of the situation were taken to Washington, D. C., for review and consideration by officers of the Departments of Agriculture and Interior. This project, which had by then become known as the Yellowstone Barkbeetle Control Project, holds the distinction of being, up until that time at least, the only bark-beetle control project to be submitted to the President of the United States for final approval. The institution of this project was disapproved by an executive order from the President's office, which in view of the many physical difficulties associated with such short-time operations was a most logical position to take. The wisdom of this action, which could not have been foreseen at that time, rests in the subsequent cessation of the outbreak with but little damage to the lodgepole pine forests of the Yellowstone National Park.

During the years following the cessation of the general plan of control in 1931, there were some scattered, more or less isolated infestations of the mountain pine beetle in lodgepole pine against which control measures were successfully directed. On the Grand Teton National Park an infestation in lodgepole pine which apparently originated from white bark pine infestations on adjacent mountainsides was successfully held to a minimum stage of epidemic development. This was also true on the Cache and Minidoka National Forests and on some portions of the Wyoming, where outbreaks in both lodgepole pine and white bark pine were successfully controlled. By 1940 all of these infestations had decreased materially in their severity, and by 1942 there were only a few light infestations distributed throughout the millions of acres of lodgepole pine and white bark pine which during the past 30 years had been ravaged by this epidemic outbreak of the mountain pine beetle. And so ends the story of this 30 year infestation of the mountain pine beetle, for these forests, the Cache and Wyoming, mark the southern limits of its range. No more forests, no more infestations.

It is interesting to note that from 1931 to 1933, inclusive, barkbeetle infestations appeared in the lodgepole pine stands of the Ashley, Unita, and Wasatch National Forests, which are to the south of the Cache and Wyoming. So close was the timing of these two groups of infestation, namely the Cache and Wyoming with the three forests to the south, that for some time no thought was given to the possibility that they were not outbreaks of the mountain pine beetle. However it was subsequently realized that the southern forests were well beyond the range of the mountain pine beetle, and that the insect responsible for the damage was the Black Hills Beetle (Dendroctonus ponderosae).

CONCLUSIONS

This story records the occurrence of a mountain pine beetle epidemic which started in northern Montana and either spread or occurred in progressive steps to the southern limits of the insects' range. Although valuable lessons have been learned as to the part which such infestations play in the ecology of our forest lands, there are still questions to be answered. The spread of such mountain pine beetle outbreaks, mountain pine beetle flights, and the reason for the cessation of such epidemics, are subjects which are still debatable. However our years of experience with this outbreak have taught us lessons which should be of great value in dealing with future epidemics of this insect in lodgepole pine. Some of these lessons are worthy of mention at this time.

As the spread or movement of mountain pine beetle outbreaks in lodgepole pine is now understood, we find that there are two phases to be considered. First, a general expansion of centers or blocks of heavy infestation, which is but a normal and natural movement of the insects from dead to living trees. Secondly, there are the so-called flights or long distance movements of beetles, which are of the greatest importance in the planning of artificial control.

Events as recorded in this story leave no doubt as to the spread of the heavy centers or blocks of infestation. The development and progression of such centers was observed year after year in the Bitterroot and Beaverhead National Forests, and in the spread of the infestation across the national forests of Idaho. In such instances a few scattered red tops are seen in an area of an otherwise canopy of green trees; the next year there are a few small spots of dead trees more scattered red tops between; then larger groups, and in four or five years entire area is red with the discolored foliage of dead

On the other hand, the occurrence of long flights of beetles for distances of miles is a more difficult fact to establish. However, lessons taught by this epidemic make such events more than just remote possibilities. In thinking of flights one does not conceive of an intelligently planned flight or migration new areas of uninfested timber but rather an ungoverned movement with the determined perhaps by air currents. Under such conditions long-distance could result in large numbers of insects being carried to timberless or timber areas, as well as to stands of susceptible

Another important lesson gained from the futile attempts to check this outbreak through the institution of artificial control is the essential role which adequate surveys play in all programs of control. Without information provided through an adequate program of forest insect surveys, control operations cannot be properly planned or directed.

In concluding this story it is quite obvious that as told it does not depict the magnitude of the destruction associated with it. It does not seem to portray the hundreds of square miles of mountain sides which appeared to be a solid red from the discolored foliage of insect-killed trees. However the occurrence of this insect situation has been told from the best information available, and those who are familiar with epidemics of the mountain pine beetle in lodgepole pine can readily visualize the destruction of timber which occurred.

In some of the accessible forest areas thousands upon thousands of insect-killed trees have been removed for fire wood. In these areas the cutting and trucking of this fuel to communities in southern Idaho became a primary forest industry, and it was from this utilization that the expression, "Dead Trees Are Worth More than Green Ones," originated. So to this end the insects were beneficial. However on many thousands of acres of forest lands the dead trees which still stand as snags or lie in tangles upon the forest floor remain as mute reminders of the destruction which occurred.

Although this forest insect epidemic is now a matter of forest history, there is still a final chapter to the story which cannot be written at this time. The material for this chapter will come from the histories of forest fires which may sweep through these inflammable areas; from the memories of the forest officers charged with the responsibilities of field activities; and from the changes in forest types and the management of areas where the lodgepole pine has been destroyed. Not only do these epidemics add almost insurmountable difficulties to the problems of forest fire suppression, but in the maintenance of forest roads and trails and telephone lines, the falling trees are a cross which must be carried for years. In this connection one cannot overlook the trials of forest travel through these devastated areas, which at its best is a difficult "Calk Shoe" task.

And so in addition to the monetary value of the timber destroyed by these outbreaks these are the after effects which in some areas are perhaps of the greatest economic importance. I do not know who will write this final chapter - perhaps it will rest in the diaries and minds of the men who must solve the problems which this forest insect epidemic left as evidence of its destructiveness.